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STUDIES ON EXPLOSIVE REACTIONS OF TETRAFLUOROETHYLENE AND ACETYLENE WITH OXYGEN OR AIR

By Ryo Kiyama, Jiro Osugi and Sigeru Kusuhara*

Introduction

A number of investigations have been made on the explosive reactions of lower unsaturated organic compounds, and have offered interesting results. The present authors studied an explosive reaction scarcely known and an explosive region undetermined by means of "admission" method in which gaseous samples were flowed into a hot vessel evacuated. The present experiment was performed in order to be compared with the data of the explosions under high pressure in this laboratory.

Tetrafluoroethylene in Part I is recently of industrial importance as a monomer of fluorocarbon compounds and the occurrence of explosion has been reported[1], but any study has not been performed yet on the explosive reactions of tetrafluoroethylene-oxygen or air mixtures.

As to acetylene in Part II many studies have been reported by means of various experimental methods, but on the explosions of acetylene-oxygen mixtures by the admission method relatively little information is available[2].

Experimentals

Materials Tetrafluoroethylene C_2F_4 used is reserved in a cylindrical glass vessel, after purified by fractionation by means of a Podbielniak-type distilation apparatus. The measurement of infrared absorption on the gas was carried out in this laboratory[3]. Acetylene gas is prepared with calcium carbide and water, purified through refining reagents and stored in a glass bulb at an atmospheric pressure (purity : 99.4～99.6%). Oxygen is used from a commercial bomb (purity : 99.4%). Air is used after being passed through two wash-bottles containing conc. aqueous solution of potassium hydroxide and conc. sulphuric acid respectively.

Apparatus and procedure The layout of the apparatus is shown in the figure below. Combustibles and oxygen or air are mixed in the glass reservoir B_1, the partial pressures of these gases being measured by the mercury manometer M_1, and reserved more than twelve hours to complete the mixing. Then making use of Toepler pump P, we transfer them into the glass reservoir B_2 until a definite pressure is attained. The glass reaction vessel having a fine tube H for the insertion of a thermocouple is evacuated to about 10^{-3} mmHg pressure and heated by the electric furnace F to a definite temperature which is measured by an alumel-chromel thermocouple T inserted

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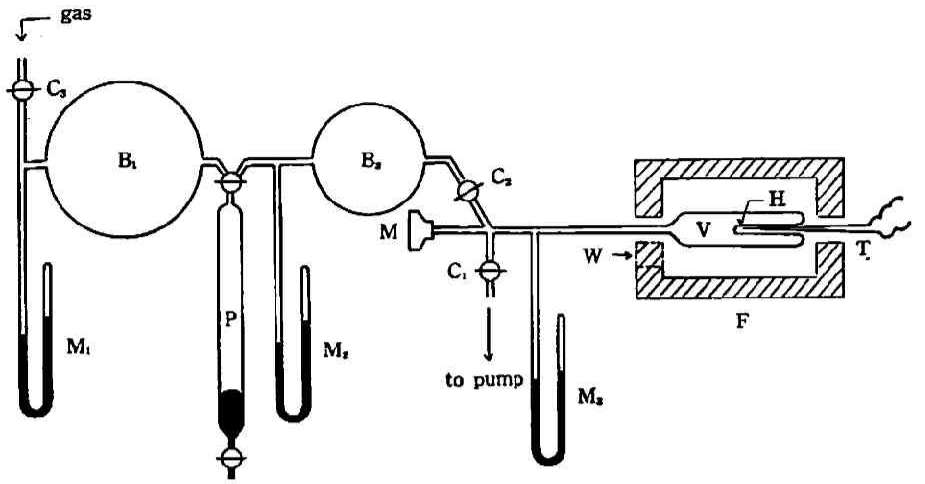
* *S. Kusuhara is in the postgraduate course, under the direction of Prof. R. Kiyama.*

1) H. C. Duss, *Ind. Eng. Chem.*, **17**, 1445 (1953)

2) P. Schäpper und M. Brunner, *Helv. Chim. Acta*, **13**, 1125 (1930)

3) R. Kiyama, M. Minomura and K. Ozawa, *This Journal*, **25**, 64 (1955)



Layout of the apparatus

B_1, B_2: gas reservoir	M: membrane pressure gauge
C_1, C_2, C_3: glass cock	P: Toepler pump
F: furnace	T: thermocouple
H: narrow tube	V: reaction vessel
M_1, M_2, M_3: mercury manometer	W: window

into the fine tube H. Immediately after the gaseous mixture in the reservoir B_2 is poured into the reaction vessel, an explosion phenomenon is observed.

The determination of the occurrence of explosion is made mainly from the observation of flame with eyes whose pupils are dilated in the dark through the window W equipped on the wall of the furnace. But in the case of the experiment of Part I we used in addition to the visual observations either an ink writing oscillograph recording the change of strain gauge pasted on the movable membrane manometer M, or an automatic mechanical pressure recorder.*

Induction period, the time between the admission of mixtures and the occurrence of explosion is measured by a stop-watch.

The reaction vessels used in Part I are those made of soft glass (at temperatures less than 350°C) and of quartz glass (at temperatures above 350°C) having the 10 cm length and 3 cm diameter. In order to examine the effect of diameter on the explosion limits, the vessels of equal length and of 1 cm and 2 cm diameters are used for mixtures of certain compositions.** The vessels used in Part II are those of the same length and of 1 cm, 2 cm and 3 cm diameters made of soft glass (at temperatures less than 400°C) and of hard glass (at temperatures above 400°C).

Experimental results and considerations of Part I and Part II are described separately.

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* The apparatus records on a rotating drum the deflection, being magnified by a lever, of the membrane due to a pressure change.

** Throughout this paper, composition will be expressed by percentage of combustibles.